BOONTON

BOONTON ELECTRONICS CORPORATION

OPERATING INSTRUCTIONS

MODELS 41A & 41AR

Microwattmeter

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DOCUMENT CONTROL ADMINISTRATOR

ERRATA NO. 1
(Model 41A)

Change and amend Operating Instructions Models 41A & 41AR Microwattmeter as follows:

1. Throughout the instruction manual, change all references to 100 kHz (or 0.1 MHz) to read: 200 kHz (or 0.2 MHz).
2. Power Detector Model 41-1A has been redesignated as Model 41-4A. Throughout the instruction manual, change all references to Model 41-1A to read: Model 41-4A.
3. The microwattmeter is supplied either with Power Detector Model 41-4A or Model 41-4B, in accordance with the customer's order. The two power detectors are identical, except the 41-4A is designed to provide a frequency response from 200 kHz to 7 GHz while the 41-4B is designed to provide a frequency response from 200 kHz to 12.4 GHz.

Page 1-1, Specifications. Make the following changes:

Delete the "Frequency Range" entry and substitute:

Frequency Range

With Power Detector Model 41-4A: 200 kHz to 7 GHz

With Power Detector Model 41-4B: 200 kHz to 12.4 GHz

Add the following item below "Frequency Range":

Useful Response (for relative measurements): 20 kHz to beyond 14 GHz

Add the following item below "Drift":

Noise: Indicator unrest <0.5 dB on most sensitive range (-50 dBm). Sensibly zero on all other ranges.

Delete the "VSWR" entry and substitute the following:

VSWR (max.)

(41-4A & 41-4B)	200 kHz to 3 GHz:	1.3
	3 GHz to 7 GHz:	1.5
(41-4B only)	7 GHz to 11 GHz:	1.5
	11 GHz to 12.4 GHz:	1.75

Page 1-3. Delete Figures 1-1 and 1-2 and substitute the following Figure 1-1:

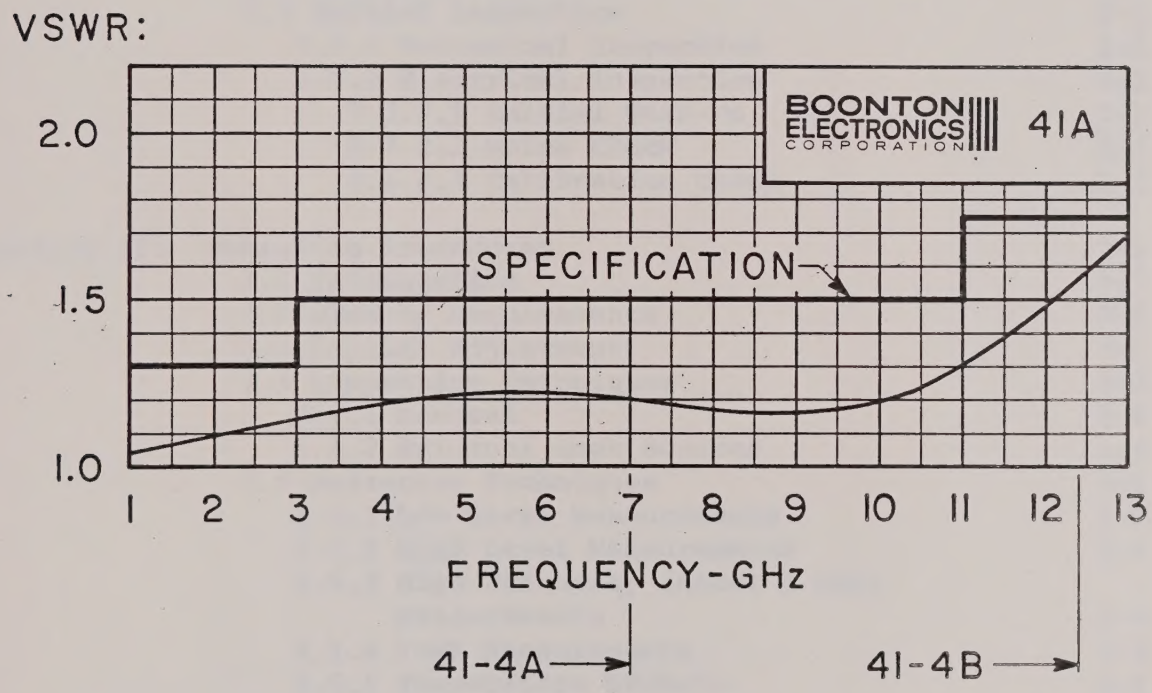

Figure 1-1. Typical VSWR Characteristic for Power Detectors 41-4A & 41-4B.

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SECTION I

General Information

1.1 Specifications

Power Range: 0.01 μW (-50 dBm) fs to +10 mW (+10 dBm) fs in 7 decade ranges

Power Sensitivity: 0.001 μW (-60 dBm)

Frequency Range: 0.2 MHz to 7 GHz

Accuracy: ±0.5 dB from 0.1 MHz to 7 GHz*
*±1 dB on most sensitive (0.01 μW) range

Drift: Less than 0.001 μW per hour

VSWR:

Frequency	VSWR, Max.
100 KHz to 3 GHz	1.3
3 GHz to 7 GHz	1.5

Power Detector: Impedance, 50Ω; equipped with precision Type N connector

Overload Limit: Input of 300 mW cw does not cause damage

DC Analog Output: Proportional to square root of input power; fs value continuously adjustable from 0 to 300 mV; output resistance, 0 to 40 KΩ, directly proportional to output level control setting.

Temperature Range: 60° F to 90° F

Primary Power: 105/125 V, 50/400 Hz or 210/250 V, 50/400 Hz, as indicated on Identification Plate. Power consumption, 35 W.

Physical Specifications:

Model 41A: 7-1/4" w x 10-1/4" d x 11" h; weight 12 lbs.
Model 41A-R: 5-1/2" x 19" panel size, 8-3/4" behind panel; weight, 16 lbs.

1.2 General Description

The Model 41A Microwattmeter extends the dynamic range of cw power measuring capability in directions of greater sensitivity and stability. It measures power levels down to -60 dBm (0.001 microwatt) and up to +10 dBm (10 milliwatts) for a total dynamic range of 70 dB.

The power detection system is based on the principle of sensing voltage across a precise 50 ohm termination with low VSWR, i.e.,

$$P = \frac{E^2}{R}$$

Voltage is detected by means of a full wave solid state detector system equalized for frequency response from 100 kHz to 7 GHz. The 50 ohm precision resistor, in conjunction with a precision Type N connector and diode loading, presents an adequate match to a 50 ohm system up to 7 GHz. Individual frequency response data are provided for each power detector to account for minor inaccuracies resulting from voltage response deviations and mismatch effects. Figure 1-1 shows a typical frequency characteristic for the power detector, and a typical VSWR Characteristic is shown in Figure 1-2.

At power levels below 10 microwatts (-20 dBm) the power detector acts as a full wave square law device, thus permitting the measurement of either pulsed or badly distorted waveforms. The rectified signal from the power detector is applied to a resistive divider network (range selector) where it is attenuated as required. The signal is converted to 95 Hz by a low noise mechanical chopper and then fed to a high-gain, feedback stabilized narrow-band ac amplifier. The amplifier output is rectified by a voltage doubling circuit, filtered, and then passed through a linearized network to compensate for the nonlinear response of the detector diodes. A sample of the linearized signal applied to the meter provides a dc analog output which is proportional to the square root of the input power.

Level of the dc output is continuously adjustable from zero to more than 300 millivolts for full scale deflection. Output resistance varies from 40,000 to 0 ohms, depending on output level setting.

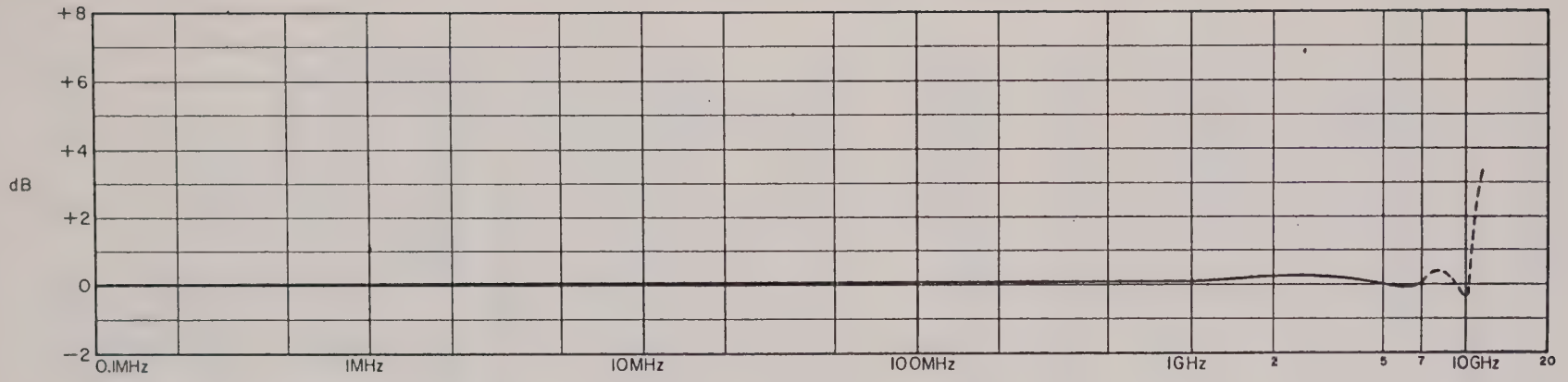

Figure 1-1. Typical Frequency Characteristic for Power Detector 41-1A (Serial No. 215 or Higher).

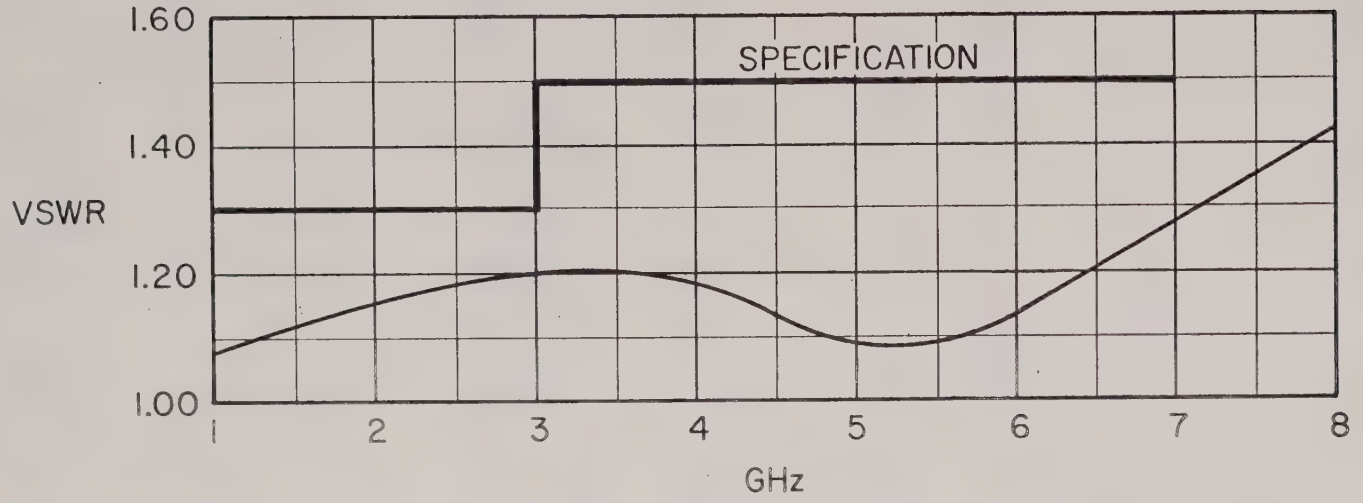

Figure 1-2. Typical VSWR Characteristic for Power Detector 41-1A.

1.3 Identification of Controls and Adjustments

1.3.1 Front Panel Controls

RANGE-FULL SCALE: Selects any of 7 ranges

FUSE: Primary power fuse

ON: Primary on/off switch

DC OUTPUT: The dc recorder output is available at these terminals. Positive terminal is ground; dc output is negative with respect to instrument ground.

On the Model 41A-R, the dc recorder output terminals are duplicated on the rear panel so that connection may be made either at the front panel or behind the rack.

POWER DETECTOR: Receptacle for connecting Power Detector Cable. It is important that the knurled ferrule be tightened firmly.

On the Model 41A-R, the POWER DETECTOR connection is duplicated at the rear panel so that input may be made either at the front panel or behind the rack. These input connections should not be used simultaneously.

ZERO: Electrical Zeroing Control. Zeroing is required for operation on the 0.01 μW, 0.1 μW, and 1 μW range only, and has no influence on the higher ranges. After a normal warm-up, the zero setting normally needs only infrequent checking.

1.3.2. Rear Panel Control

DC OUTPUT ADJ: Permits adjusting the full scale value of the dc recorder output to any value from 0 to at least 300 mV.

On the Model 41A-R, this adjustment is located on the front panel.

NOTE: Full scale range adjustments are accessible through ports along the right and left side of the instrument. These controls need adjustment only when the instrument is being completely recalibrated. Otherwise their settings should not be disturbed.

SECTION II

Initial Installation

2.1 Shipping Container Contents

The following are included in the shipping container, packed with the instrument:

1 Model 41-1A Power Detector with cable and connector assembly.

1 Operating Instruction Book.

2.2 Warranty Registration Card

The Warranty Registration Card is attached to all instruments shipped to commercial users. Please fill out this card and mail it promptly (no postage required).

There is provision on this card for placing the names of interested individuals on the Boonton Electronics' Technical Data mailing list.

2.3 Initial Inspection

2.3.1. Mechanical Inspection

After the instrument has been unpacked and inspected visually for possible damage sustained in transit*, it may be put into service by the following procedure:

With the instrument unpowered and in a normal operating position, check the pointer zero position, and if necessary, adjust the mechanical zero control so that the pointer is aligned with the zero reference (the calibration at the extreme left side of the scale).

2.3.2 Electrical Inspection

2.3.2.1 Initial Turn-on

With the power cord plugged into a suitable ac power source, turn the instrument on and allow a warm-up period of approximately 15 minutes. If the instrument has been exposed to temperatures beyond its normal

*If damage is found, follow instructions on the last page of this Instruction Book.

operating range (60°F to 90°F) allow a longer period to achieve full thermal stabilization.

The scale of this instrument is illuminated and serves as the pilot lamp.

> IMPORTANT - The instrument should be plugged only into a power source having the voltage and frequency indicated on the instrument's identification plate.

Connect the Power Detector cable to the POWER DETECTOR receptacle on the front panel, being careful to tighten the knurled ferrule firmly.

> IMPORTANT - Check to see that the serial number of the Power Detector matches that of the instrument. Each instrument is calibrated for its particular detector, and use of a detector other than that for which the instrument was calibrated may result in errors in measurement.

2.3.2.2 Noise Check

With the Power Detector shielded and with no power input, switch to the 0.01 μW range. Set the pointer to the calibration mark at the extreme left end of the scale. Indicator unrest should not exceed approximately ± 1/4 inch. (See zero adjustment 3.3.c)

> NOTE: This test should not be made in the presence of exceptionally intense fields.

2.3.2.3 Calibration Check

The calibration of this instrument was carefully checked before shipment, and its stability is such that there is no need to check calibration before putting the instrument into service. However, if desired, calibration can be checked by the following procedure:

1. Connect an oscillator having low distortion output of up to 1 volt into 50 ohms at 200 KHz to the input of the Model 41A.
2. Using a suitable Tee Connector, connect an ac voltmeter having an accuracy of 1% or better at 200 KHz to monitor the oscillator output.
3. Follow the zeroing procedure given in paragraph 3.3.

4. Apply the 200 KHz signal at the levels indicated for each range in the table below. The pointer should come to rest at the -1 dBm calibration mark (within allowable tolerance).

Range, dBm	+10	0	-10	-20	-30	-40	-50
Level, mV	630	199	63.0	19.9	6.30	1.99	0.63

SECTION III

Operating Procedures

3.1 Introduction

The Model 41A and Model 41A-R measure cw power in a 50 ohm system over a frequency range from 200 kHz to 7 GHz and over a power range from 0.01 microwatt (-50 dBm) full scale to 10 milliwatts (+10 dBm) in seven decade ranges. The meter scale is calibrated in both microwatts and dBm (0 dBm equals 1 milliwatt in 50 ohms).

The Power Detector is individually calibrated. A correction curve for high frequency effects is mounted on the Power Detector barrel and is used for measurements at 1 GHz and above.

3.2 Warm-up Requirements

Measurements may be made with the instrument a minute or two after turn-on, and it will measure within specified accuracy within approximately 15 minutes, providing the instrument (including Power Detector) is starting from an ambient temperature within the normal operating range (60° F to 90° F). However, for maximum accuracy the instrument should be allowed time to achieve full thermal stabilization -- approximately 1 hour.

3.3 Initial Adjustment

If measurements are to be made on the 10 μW range or above, no initial adjustment is required. If measurements are to be made on the 0.01 μW, 0.1 μW or 1 μW range, the zero adjustment should be performed as follows:

a. Set the RANGE-FULL SCALE selector to the 0.01 μW range

b. Check to see that no signal is applied to the power detector and that both the instrument and the detector are not subjected to strong ac fields.

c. Adjust the ZERO control to bring the pointer in the direction of the zero reference (the black/red line to the left of the lowest calibration). Since there is a slight delay between adjustment of the control and the pointer motion, the zero reference may be over or undershot on the first attempt. After the initial coarse adjustment, wait a moment or two for the pointer to come to rest. Then apply a series of small corrective adjustments, waiting between each for the pointer to assume its new position until proper zeroing is achieved.

Because of the great sensitivity of the instrument on the 0.01 μW range, indicator fluctuation up to ±0.5 dB can be expected. Proper zero adjustment is achieved when the pointer fluctuates around the zero reference line.

NOTE

Prolonged handling of the Power Detector immediately prior to, or during, this operation should be avoided to eliminate the possibility of upsetting the thermal equilibrium of the detector elements.

3.4 Connection Techniques

3.4.1 General

The Power Detector of this instrument is equipped with a precision Type N connector for connection to the power source under study. There are several precautions, however, which should be observed if optimum results are to be obtained.

3.4.2 External Heat Sources

Even with the Power Detector carefully insulated against external variations in temperature, it is advisable to locate the Detector away from the immediate vicinity of heat sources when operating on either of the two most sensitive ranges. For example, if monitoring the output of equipment which generates heat significantly above the ambient temperature, the Power Detector should be connected by a sufficient length of cable to allow free circulation of air, rather than being fixed directly to a warm output connector. If such a connection is unavoidable, sufficient time should be allowed for the total assembly, including the Power Detector, to come to thermal equilibrium.

3.5 Measuring Techniques

3.5.1 Low Level Measurements

The Model 41A will provide reliable, reproducible measurements of cw power levels as low as 0.001 microwatt (-60 dBm). The Model 41A can be used at slightly derated accuracy (±1 db) for pulse work. The peak power, however, should not exceed 30 μW (-15 dBm) at average power levels below 15 μW (-18 dBm). Above these levels the detector increasingly functions as a peak detector and accuracy, except for cw, cannot be guaranteed. When using the three most sensitive ranges (0.01 μW, 0.1 μW, and 1 μW, the preliminary zero adjustment is required and should be performed as described in paragraph 3.3

NOTE

When switching from the 1000 μW range (or higher) to the 0.01 μW range, a recovery time of up to 30 seconds may be required before the instrument returns to zero.

3.5.2 High Level Measurements

When measuring on the 10 μW, 100 μW, 1000 μW, or 10 K μW range, no zero adjustment or other preliminary procedure is required. However, it should be noted that this instrument is not recommended for measurements where peak pulse power exceeds 30 microwatts, since errors may be incurred when pulses exceed the square-law response of the Power Detector. For cw power, measurements within specified accuracy will be obtained up to 10 milliwatts.

3.5.3 High Frequency (above 1 GHz) Measurements

To achieve maximum accuracy from 1 GHz to 7 GHz, the correction chart on the Power Detector barrel should be used. The correction factor is added algebraically. For example, if the instrument reads -22.1 dBm at 3 GHz and the correction from the chart at 3 GHz is +0.2 dBm, the corrected value is -21.9 dBm.

NOTE

The Model 41-1A Power Detector is calibrated for use with a low VSWR 50 ohm source. A large deviation from 50 ohms may result in mismatch error. However, this mismatch error can be reduced by inserting a calibrated low VSWR attenuator (VSWR < 1.10) between the questionable source and the power detector. Another alternative is the insertion of a low loss tuner.

3.5.4 VSWR Measurements

The high sensitivity of the Power Detector enables the 41A or 41A-R to perform voltage standing wave ratio (VSWR) measurements. In this application, the 7 GHz frequency limit of the instrument may be extended above 10 GHz. The VSWR is determined by measuring the dB difference between a power maximum and a power minimum on a

slotted line and converting the Δ dB to a VSWR value. An adapter is required, however, to couple the slotted line to the instrument. Acceptable combinations include General Radio's Slotted Line Model 874 LB or 900 LB with adapter GR 874 QNJA and Hewlett Packard's Universal Probe Carriage Model 809C with Boonton Electronics' Slotted Line Adapter 41-3A. Slotted lines of other manufacturers also may be used if a suitable adapter is available for the slotted line.

Perform VSWR measurements in accordance with the procedure below.

a. Connect Power Detector 41-1A to the sliding carriage with a suitable adapter.

b. Slide the carriage along the slotted line and locate a power maximum.

c. Adjust the probe penetration for the least coupling which will yield a -41 dBm reading on the 41A or 41A-R meter.

NOTE 1: Incident power should be on the order of 0 dBm or greater.

NOTE 2: Be sure to zero the 41A or 41A-R with the signal source turned off.

d. Adjust the source level so that the 41A or 41A-R meter indicates -41 dBm (this is a convenient point).

e. Slide the carriage along the slotted line and locate a power minimum. Note the meter reading (dBm) and subtract the minimum dBm reading from the maximum (ignore signs). This Δ dB now can be converted into VSWR by using either the VSWR Conversion Curve in Figure 3-1 or a slide rule. (VSWR is the antilogarithm, base 10, of $\frac{\Delta \text{ dB}}{20}$.)

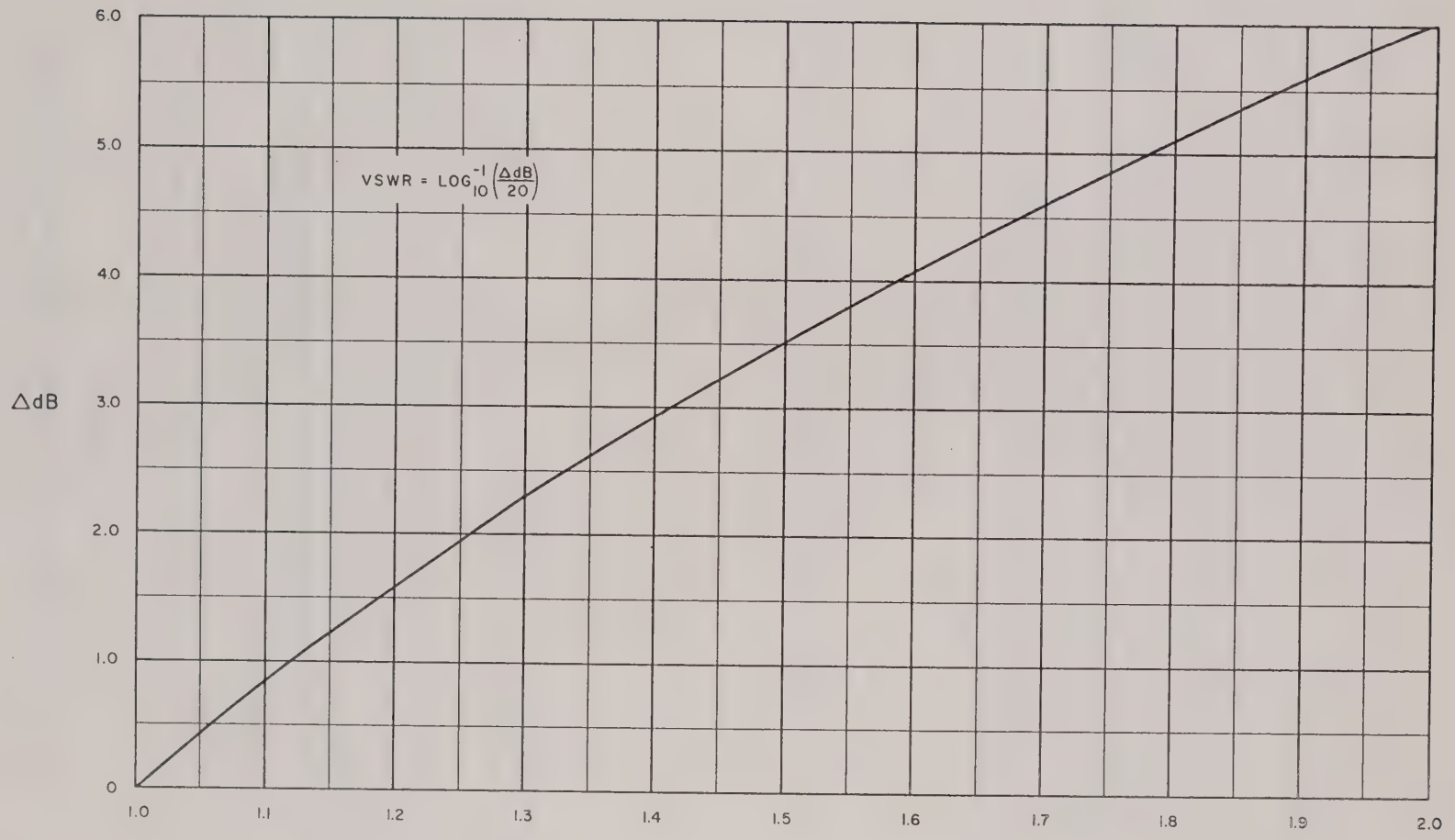

Figure 3-1. Conversion Curve for VSWR Measurements.

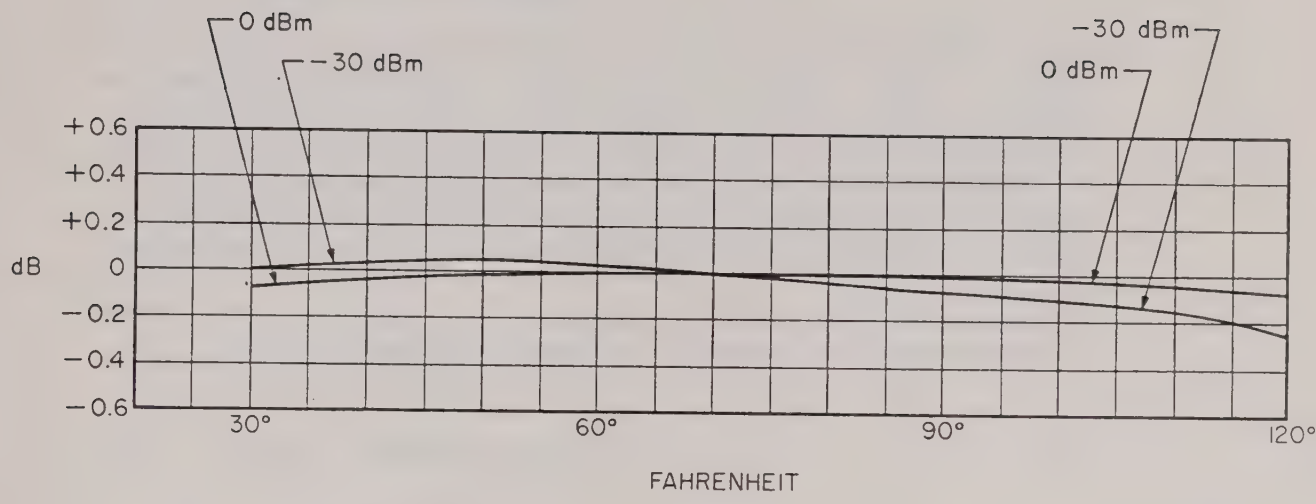

Figure 3-2. Typical Temperature Characteristic for Power Detector 41-1A.

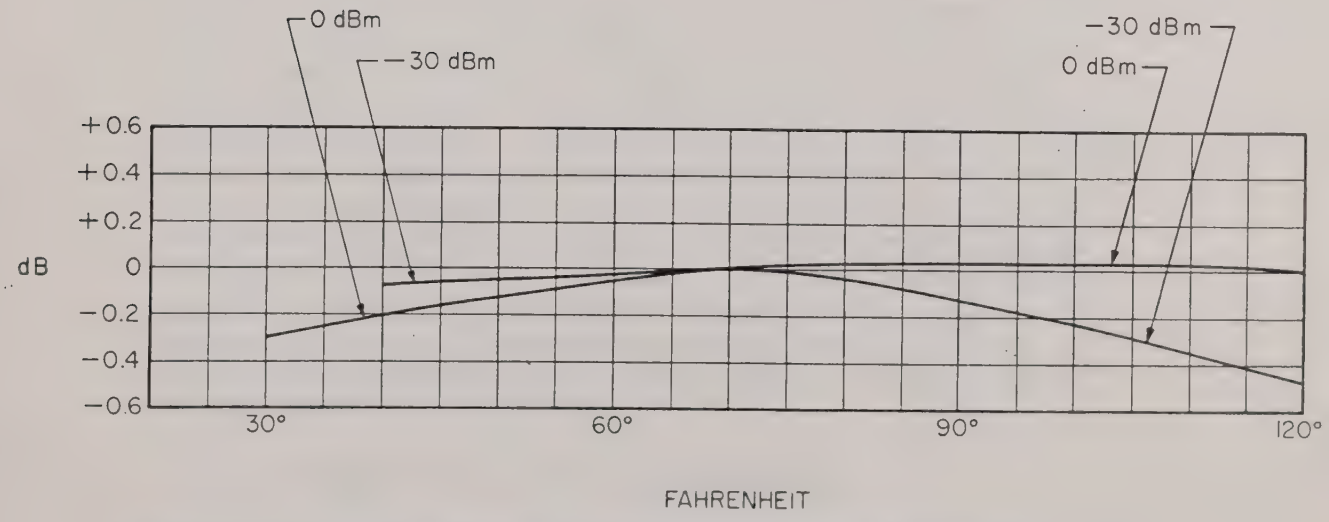

Figure 3-3. Typical Temperature Characteristic for Microwattmeter 41A (or 41A-R) and Power Detector 41-1A.

3.5.5 Temperature Effects

The accuracy specifications for the Model 41A apply over an ambient temperature range from 60° F to 90° F. Operation of the equipment is possible outside these limits, but some inaccuracies can be expected. Figure 3-2 shows a typical temperature characteristic of Power Detector 41-1A, and Figure 3-3 shows a typical temperature characteristic of both the microwattmeter and the power detector.

NOTE: For optimum zero stability, the Power Detector and instrument should be allowed to achieve the ambient temperature.

3.6 Input Overload Limits

3.6.1 CW Overload Limits

Up to 300 milliwatts may be applied to the Power Detector without damaging the detector. CW inputs above this level may cause permanent damage.

3.7 DC Output

3.7.1 General

The dc output provided at the front panel binding posts is proportional to the square root of the input power level or, directly proportional to the input voltage. It is useful over the calibrated range of the panel meter. Use below the calibrated portion of the scale is not recommended. Polarity of the dc output is negative with respect to the instrument ground; the positive dc output terminal is at ground potential. Output resistance varies from 0 to 40K, depending on the output level setting. The dc output is continuously variable from 0 to 300 millivolts for full scale deflection on all ranges by means of the DC OUTPUT ADJ control located on the rear panel of the 41A and on the front panel of 41A-R.

3.7.2 Adjustment of the DC Output Level

The full scale value of the dc output can be adjusted by applying a full scale signal to the Power Detector and adjusting the dc output level control for the desired value. A high impedance dc voltmeter is recommended for this purpose.

Adjustment of the dc output level has no influence on the instrument's calibration accuracy. A full short circuit across the dc output terminals does not affect the meter reading.

The meter scale calibration (microwatts or dBm) may be transferred to a recorder simply by adjusting the input rf power to the desired points and noting each stylus position.

SECTION IV

Theory of Operation

The theory of operation of the Model 41A Microwattmeter can best be explained using the Block Diagram of Figure 4-1. The instrument comprises a solid state rf-to-dc converter, a dc voltage divider, a low noise mechanical chopper, a stable amplifier, an ac-to-dc converter, linearizing circuits, and a meter.

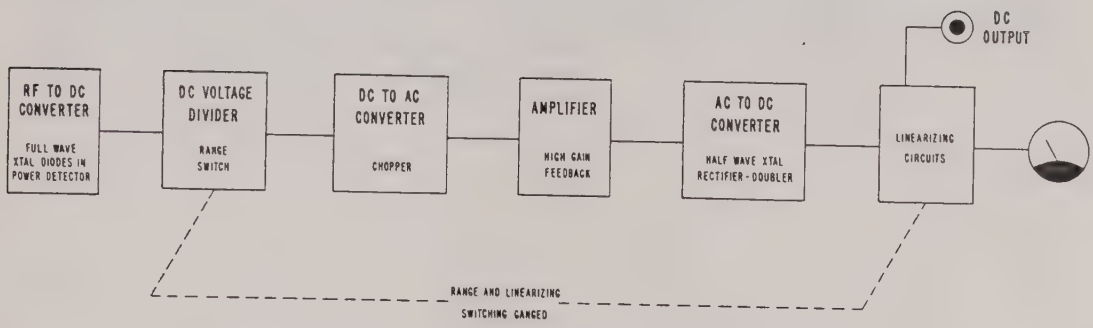

Figure 4-1. Block Diagram, Model 41A

4.1 Power Detector

The Power Detector embodies a full wave diode detector which rectifies the signal under study to a dc voltage whose level is a function of the input level. While operating in the square-law region (below approximately 15 microwatts) the detector provides true rms response. As the input level increases beyond 15 microwatts, waveform response gradually approaches peak-to-peak, calibrated on the scale in dBm, and microwatts.

In addition to increasing efficiency, the use of full wave rectification in the Power Detector permits measurement of signals having highly asymmetrical waveforms without errors.

The diodes used in the detector have been carefully selected for specific characteristics. The user is urged NOT to attempt their replacement with <u>any</u> off-the-shelf types. In case of damage to detector components, contact your local Boonton Electronics Sales Engineering Representative or the factory for instructions.

4.2 Amplifier

The dc output from the detector is passed through a voltage

dividing network (range selector) where it is attenuated as required before being converted to ac at a frequency of 95 Hz by the low noise chopper. The chopper output is applied to the narrow band, feed-back stabilized amplifier. Filter networks at the input greatly attenuate extraneous noise and rf pick-up to the point where special precautions to avoid the effects of external fields are required only under the most unusual circumstances.

The ac output from the amplifier is then rectified by a voltage doubler and passed through a diode network to convert the signal to a linear voltage suitable for metering. The output of the linearizing network is also available at front panel terminals for external use.

SECTION V

Maintenance

5.1 Periodic Calibration

The Model 41A is designed to provide trouble-free operation over extended periods of time. The Model 41A should be checked periodically, however, to verify proper calibration. To make such calibration checks, the following equipment is required:

a. A reliable signal source between 300 kHz and 1 MHz with less than 1% distortion at levels up to 0.707 volts across 50 Ω.

b. A precision electronic voltmeter of the averaging type such as the Ballantine Models 310A or 314, or the Hewlett-Packard Model 400H.

5.2 Precautions When Checking Calibration

Before checking calibration, the accuracy of the ac monitoring meter should be verified using a low frequency (50 - 100 c/s) source of good waveform and a precision type ac meter of at least 1% accuracy.

When checking the calibration on an instrument having the sensitivity and bandwidth of the Model 41A, it is essential to take precautions to avoid errors resulting from stray pick-up voltages. A well-shielded signal source must be used in conjunction with coaxial connections to both the Model 41A and the standard reference meter. Even with a well-shielded generator and associated connections, it is sometimes possible for the reference meter to pick up stray rf signals and feed them into the probe. It is advisable to test for this condition by disconnecting the standard meter and noting any change in level.

5.3 Calibration Check

Using the equipment reference in paragraph 5.1 and observing the procedure outlined in paragraph 5.2, the calibration of the Model 41A should be checked on each range using a test voltage as indicated in Table II. If the check reveals that recalibration is required, the procedure outlined in paragraph 5.4 should be followed.

5.4 Calibration Procedure

The Model 41A should be calibrated at an ambient temperature of 70° to 80° F when it is fully warmed up (after at least 2 hours). DO NOT REMOVE THE INSTRUMENT FROM ITS CASE FOR CALIBRATION.

Access ports to all calibration controls are located along the lower right and left sides of the instrument. The control identification numbers referenced in the following procedure appear on the plates mounted just above the access ports.

Step 1. Set RANGE-FULL SCALE selector to the -50 dBm range and zero the instrument (See paragraph 3.3c).

Step 2. Set RANGE-FULL SCALE selector to the +10 dBm range; apply 251 mV input; and adjust control #1 for a -9 dBm reading.

Step 3. On the +10 dBm range, apply 630 mV input and adjust control #2 for a -1 dBm reading.

Step 4. On the +10 dBm range, apply 251 mV input again and readjust control #1 for a -9 dBm reading.

Step 5. On the +10 dBm range, apply 630 mV input again and readjust control #2 for a -1 dBm reading.

Step 6. Alternately repeat steps 4 and 5 until range is calibrated (when adjustment of one control ceases to require readjustment of the other).

Step 7. Set RANGE-FULL SCALE selector to the 0 dBm range. Apply 199 mV input and adjust control #3 for a -1 dBm reading.

Step 8. Set RANGE-FULL SCALE selector to the -10 dBm range. Apply 25.1 mV input and adjust control #4 for a -9 dBm reading.

Step 9. Set RANGE-FULL SCALE selector to the -10 dBm range. Apply 63.0 mV input and adjust control #5 for a -1 dBm reading.

Step 10. Alternately repeat steps 8 and 9 until range is calibrated.

Step 11. Set RANGE-FULL SCALE selector to the -20 dBm range. Apply 19.9 mV input and adjust control #6 to a -1 dBm reading.

Step 12. Adjust ZERO as in paragraph 3.3c.

Step 13. Set RANGE-FULL SCALE selector to the -30 dBm range. Apply 2.51 mV input and adjust control #7 for a -9 dBm reading.

Step 14. Without altering range setting, apply 3.98 mV input, and adjust control #8 for a -5 dBm reading.

Step 15. Without altering range setting, apply 6.30 mV input, and adjust control #9 for a -1 dBm reading.

Step 16. In sequence, repeat steps 13, 14, and 15 several times, until range is calibrated.

Step 17. Set RANGE-FULL SCALE selector to the -40 dBm range. Apply 1.99 mV input and adjust control #10 for a -1 dBm reading.

Step 18. Set RANGE-FULL SCALE selector to the -50 dBm range. Apply 0.630 mV input and adjust control #11 for a -1 dBm reading.

NOTE: The controls for the low end, or the -9 dBm scale point, are gain adjustments. Each gain adjustment controls two ranges. On some instruments a better calibration may be achieved by compromising on the setting of these common controls for the best overall results between the ranges involved. Table I is a calibration procedure depicted in table form.

Calibration of the Model 41A is now complete, except for a brief check, as outlined in paragraph 5.3 to assure that the calibration has been properly accomplished.

5.5 Trouble Shooting Procedure

5.5.1 Case Removal

The instrument may be removed from its case after first removing the two screws located at the back of the case (near the bottom) and the four screws located on the sides of the case near the front.

The power supply may be removed from the case after removing the four screws located on the sides of the case near the rear.

5.5.2 Tube Replacement

If the tube V1 should become weak or noisy, it should be replaced with BEC 525001 or a commercial low noise 12AX7. The Telefunken ECC83/12AX7 has been found to meet these require ments consistently. After replacing defective tubes, check

calibration as outlined in Paragraph 5.3 and calibrate, if necessary, as described in Paragraph 5.4.

5.5.3 Chopper Replacement

If satisfactory operation is not obtained by replacing tubes, a replacement chopper should be tried. (NOTE: The chopper used in the Model 41A is a special BEC part. For replacement or spares, contact your local Boonton Electronics Representative, or call the factory directly.) If the new chopper does not clear the difficulty, place the original chopper back in socket. If the new chopper is installed the calibration accuracy must be rechecked, and, if necessary, the instrument should be recalibrated.

5.5.4 Voltage and Resistance Tests

After determining that the trouble cannot be cured by replacement of tubes or chopper (as described above) it is advisable to make a systematic check of the ac voltage, dc voltage, and resistance to ground from each pin of each tube socket. Table III shows the nominal ac and dc voltages to ground from each pin; Table IV shows the nominal resistances to be expected at each point. Large or erratic deviations from the listed values will serve as a valuable clue in tracking down a faulty component. Once the trouble has been found and corrected, the calibration must be rechecked and readjusted as outlined in Paragraph 5.3 and Paragraph 5.4.

5.5.5 Replacement of Power Detectors

The serial number of the instrument matches that of the power detector with which it was calibrated at the factory. If it is necessary to change detectors for any reason, the instrument's calibration MUST be rechecked. In the majority of cases, full recalibration (see procedure in Paragraph 5.3) will be required.

5.6 Adjustment of R166

If the chopper driver is replaced, it will be necessary to adjust the twin tee filter. This is accomplished as follows:

Remove the chassis from the cabinet, but do not disconnect from the power supply. With instrument operating, set the range selector to the -50 dBm range, adjust the ZERO control to give a reading of greater than half scale. Adjust R166 for a peak upscale reading. R166 is accessible through a hole in the rear center of the chassis. It may be necessary during this adjustment to readjust the ZERO

control to keep the pointer on scale. When approaching the peak, the adjustment should be made slowly to allow the pointer time to follow.

41A
b

CALIBRATION TABLE I

Step	Range Setting	Applied Voltage	Adjustment Control No.	Scale Reading	
1	-50dBm	0	None		Adjust Zero (See Paragraph 3.3.c)
2	+10dBm	251mV	#1	-9dBm	Gain adjustment for the +10 and the 0dBm ranges
3	+10dBm	630mV	#2	-1dBm	Repeat Steps 2 & 3 until range is calibrated
4	0dBm	199mV	#3	-1dBm	
5	-10dBm	25.1mV	#4	-9dBm	Gain adjustment for the -10 and the -20dBm ranges
6	-10dBm	63.0mV	#5	-1dBm	Repeat Steps 5 & 6 until range is calibrated
7	-20dBm	19.9mV	#6	-1dBm	
8	-50dBm	0	None		Adjust Zero (See Paragraph 3.3.c)
9	-30dBm	2.51mV	#7	-9dBm	Gain adjustment for the -30 and the -40dBm ranges
10	-30dBm	3.98mV	#8	-5dBm	
11	-30dBm	6.30mV	#9	-1dBm	Repeat Steps 9, 10, and 11 until range is calibrated
12	-40dBm	1.99mV	#10	-1dBm	
13	-50dBm	0	None		Adjust Zero (See Paragraph 3.3.c)
14	-50dBm	0.630mV	#11	-1dBm	

NOTE: On some instruments a better calibration may be achieved by compromising on the setting of the gain adjustments for the best results between the ranges involved.

TABLE II

INPUT VOLTAGE IN MILLIVOLTS

Range Full Scale	dBm SCALE INDICATION											
	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11
+10 dBm	707	630	562	501	446	398	354	316	282	251	224	199
0 dBm	224	199	178	158	141	126	112	99.9	89.0	79.3	70.7	63.0
-10 dBm	70.7	63.0	56.2	50.1	44.6	39.8	35.4	31.6	28.2	25.1	22.4	19.9
-20 dBm	22.4	19.9	17.8	15.8	14.1	12.6	11.2	9.99	8.90	7.93	7.07	6.30
-30 dBm	7.07	6.30	5.62	5.01	4.46	3.98	3.54	3.16	2.82	2.51	2.24	1.99
-40 dBm	2.24	1.99	1.78	1.58	1.41	1.26	1.12	0.999	0.890	0.793	0.707	0.630
-50 dBm	0.707	0.630	0.562	0.501	0.446	0.398	0.354	0.316	0.282	0.251	0.224	0.199

TABLE III

VOLTAGE MEASUREMENTS

Conditions:

117V 60∿ line input.
VTVM used for all measurements.
All measurements to chassis unless otherwise noted.
Input 6.3 mV at any frequency between 300 kHz and 1 MHz.
Use Ballantine Model 314 VTVM for all AC voltage measurements.
RANGE-FULL SCALE selector set to -30 dBm range.

Pin #		1	2	3	4	5	6	7	8	9	10	11
Tube V101 Ass'y	DC	140	3.0	0.5	0.75	6.3	85	0	0.8	0	-	-
	AC			0.04			0.04				-	-
V102 (6AU6)	DC	0.5	1.5	12.6	6.3	20	30	1.5				
	AC	0.04	0.03	0.5	0.025	0.15	0.03	0.03				
V103 (7199)	DC	300	150	75	0	0	2	0	200	100	-	-
	AC	0.15	8	0.3	6.3	1	2	40	7	9	-	-
V201 (6X4)	DC							400				
	AC	350		0	0		350					
V202 (0A2)	DC	150	0			150						
	AC											
11 Pin Socket	DC							150	300	0	0	12.6
	AC	0	6.3	115		0.02						0.5

TABLE IV

RESISTANCE MEASUREMENTS

Conditions:

Power turned off.

Tubes in socket, chassis interconnected (11 Pin), all measurements to chassis.

Pin # / Tube	1	2	3	4	5	6	7	8	9	10	11
V101 Ass'y	65K	6.8M	835K	11K	4Ω	500K	0	6.8K	0	-	-
V102 (6AU6)	835K	3K	8Ω	4Ω	500K	1M	3K	-	-	-	-
V103 (7199)	30K	250K	1M	0	1Ω	1.8K	1M	20K	1M	-	-
V201 (6X4)	300	-	0	0	-	300	30K	-	-	-	-
V202 (OA2)	20K	0	-	0	20K	-	0	-	-	-	-
11 Pin Conn.	0	0	∞	∞	4Ω	-	20K	30K	0	0	8Ω

ADDENDUM NOTICE

Model 41A

In the Table of Replaceable Parts, on PL-1 and PL-2 make the following changes:

1) On PL-2; issue 41A,c; change (for S/N 337 and above):

DR101	Chopper Driver	Airpax CD232	540,114
to read:			
DR101	Chopper Driver	BEC	041020

2) On PL-1; issue 41A,a; change (for S/N 436 and above):

C112	Capacitor	0.005μF,200V,10%	230,121
to read:			
C112	Capacitor	0.0047μF,200V,10%	234074

TABLE OF REPLACEABLE PARTS

Reference		Description				BEC Part No.
C101	Capacitor,	0.1	µF	50 V	10%	234,046
C102	"	0.1	µF	50 V	10%	234,046
C103	"	0.1	µF	50 V	10%	234,046
C104	"	0.1	µF	50 V	10%	234,046
C105	"	0.022	µF	200 V	10%	234,042
C106	"	0.0033	µF	200 V	10%	234,043
C107	"	0.0033	µF	200 V	10%	234,043
C108	" Elect.	30	µF	350 V		283,161
C109	" Elect.	50	µF	6 V		283,145
C110	" Elect.	50	µF	6 V		283,145
C111	"	0.1	µF	200 V	10%	230,116
C112	"	0.005	µF	200 V	10%	230,121
C113	"	0.5	µF	100 V		234,034
C114	" Elect.	100	µF	6 V		283,171
C115	"	0.1	µF	200 V	10%	230,116
C116	"	0.1	µF	200 V	10%	230,116
C117	"	0.047	µF	200 V	5%	234,026
C118	"	0.002	µF	200 V	5%	234,024
C119	" Elect.	50	µF	6 V		283,145
C120	"	0.022	µF	200 V	10%	230,101
C121	"	0.022	µF	200 V	10%	230,101
C122	"	0.022	µF	200 V	10%	230,101
C123	"	0.1	µF	200 V	10%	230,116
C124	"	0.1	µF	200 V	10%	230,116
C125	" Elect.	50	µF	6 V		283,145
C126	"	0.1	µF	200 V	10%	230,116
C127	"	1.0	µF	200 V	20%	230,104
C128	" Elect.	5	µF	50 V		283,143
C201	Capacitor, Elect.	3X20	µF	450 V		283,113
C202	" Elect.	2X1000	µF	15 V		283,114
CR101	Diode, Silicon		1N251			530,043
CR102	" "		SG3113			530,040
CR103	" "		SG3113			530,040
CR104	" "		1N600			530,008
CR105	" "		SG3113			530,040
CR106	" "		1N600			530,008
CR107	" "		SG3113			530,040
CR201	Rectifier	Sarkes Tarzian				532,001

Reference		Description	BEC Part No.
DR101	Chopper Driver	Airpax #CD232	540,114
DS101	Lamp	GE #51	545,103
DS102	"	GE #51	545,103
F101	Fuse	0.5 Amp MDL	545,504
G101	Chopper	BEC Special	540,113
L101	RF Coil	4.7 µH	400,113
L103	"	470 µH	400,116
L201	Choke	Stancor #C-1707 7 Hy	440,001
M101	Meter	95 µA	554,178
R101	Resistor,	1.91 KΩ 1/2 W 1%	306,273
R102	"	22 MΩ 1/2 W 5%	301,191
R103	"	1.8 K 1/2 W 5%	301,093
R104	"	7.68 K 1/2 W 1%	306,346
R105	"	75 K 1/2 W 1%	306,463
R106	"	750 K 1/2 W 1%	306,583
R107	"	5.11 MΩ 1/2 W 1%	306,788
R108	"	330 K 1/2 W 5%	301,147
R109	" Var.	50 K 2 W 10%	311,129
R110	"	1.91 K 1/2 W 1%	306,273
R111	"	15 K 1/2 W 5%	301,115
R112	"	300 Ω 1/2 W 5%	301,074
R113	"	7.68 K 1/2 W 1%	306,346
R114	"	75 K 1/2 W 1%	306,463
R115	"	750 K 1/2 W 1%	306,583
R116	"	5.11 MΩ 1/2 W 1%	306,788
R117	"	330 K 1/2 W 5%	301,147
R118	"	390 K 1/2 W 5%	301,149
R119	"	2.2 K 1/2 W 5%	301,095
R120	"	10 Ω 1/2 W 5%	301,039
R121	"	2.7 K 1/4 W 5%	300,092
R122	"	10 Ω 1/2 W 5%	301,039
R123	"	6.8 MΩ 1/4 W 5%	300,174
R124	"	2.4 Ω 1 W 5%	310,001
R125	"	100 Ω 1/2 W 5%	301,063
R126	"	1.2 K 1/2 W 5%	301,089
R127	"	10 K 1/2 W 1%	306,359
R128	"	1 MΩ 1/2 W 5%	301,159
R129	"	825 K 1/2 W 1%	306,589
R130	"	6.8 K 1/4 W 5%	300,102
R131	"	2.2 MΩ 1/4 W 5%	300,162

Reference			Description				BEC Part No.
R132	Resistor,	470	K	1/4	W	5%	300,146
R133	"	6.8	K	1/2	W	5%	301,107
R134	"	47	K	1/2	W	5%	301,127
R135	"	1	K	1/4	W	5%	300.082
R136	"	27.4	K	1/2	W	1%	306,411
R137	"	100	K	1/2	W	1%	306,478
R138	"	51	K	1/2	W	5%	301,128
R139	"	3.3	M	1/2	W	5%	301,171
*R140	"	62	K	1/2	W	5%	301,130
R141	"	3.9	K	1/2	W	5%	315,002
R142	" Var.	5	K	2	W	20%	311,221
R143	"	470	K	1/2	W	5%	301,151
R144	"	43	K	1/2	W	5%	301,126
R145	"	68	K	1/2	W	5%	301,131
R146	" Var.	50	K	2	W	10%	311,208
R147	" Var.	5	K	2	W	20%	311,221
R148	"	1	MΩ	1/2	W	5%	301,159
R149	" Var.	2	K	2	W	10%	311,126
R150	" Var.	5	K	2	W	20%	311,221
R151	"	150	K	1/2	W	5%	301,139
R152	"	150	K	1/2	W	5%	301,139
R153	"	560	K	1/2	W	5%	301,153
R154	"	681	K	1/2	W	1%	306,578
R155	" Var.	50	K	2	W	20%	311,163
R156	"	22	K	1/2	W	5%	301,119
R157	" Var.	50	K	2	W	20%	311,163
R158	"	15	K	1/2	W	5%	301,115
R159	" Var.	25	K	2	W	20%	311,115
R160	"	8.2	K	1/2	W	5%	301,109
R161	" Var.	25	K	2	W	20%	311,115
R162	"	8.2	K	1/2	W	5%	301,109
R163	" Var.	25	K	2	W	20%	311,115
R164	"	22	K	1/2	W	5%	301,119
R165	" Var.	25	K	2	W	20%	311,115
R166	" Var.	20	K	1/2	W	10%	311,223
R167	"	1	MΩ	1/2	W	5%	301,159
R168	"	1.8	K	1/2	W	5%	301,093
R169	"	220	K	1/2	W	5%	301,143
R170	"	1	MΩ	1/2	W	5%	301,159
R171	"	6.2	K	1/2	W	5%	301,106
R172	"	1	MΩ	1/2	W	5%	301,159
R173	"	15	K	1/2	W	5%	301,115
R174	"	6.2	K	1/2	W	5%	301,106
R175	"	680	Ω	1/2	W	5%	301,083
R176	"	20	K	2	W	5%	304,118
R177	"	13	K	1/2	W	5%	301,114

W A R R A N T Y

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship for a period of one year from date of shipment for instruments, probes, power sensors and accessories. Boonton Electronics further warrants that its instruments will perform within all current specifications under normal use and service for one year from date of shipment. These warranties do not cover active devices that have given normal service, sealed assemblies which have been opened or any item which has been repaired or altered without Boonton's authorization.

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